[Document Name]Description

[Title of the Invention]An electrode connection structure object and a manufacturing method for the same

[Claim(s)]

[Claim 1]A not less than 900 ** inside metal layer is formed in the surface of spherical substrate particulates which consist of plastic material for a melting point, An electrode connection structure object, wherein a conductive particle which comes to form a melting point an outside metal layer 350 ** or less in the outside of the inside metal layer is allocated between electrodes which counter and melting adherence of the outside metal layer of this conductive particle is carried out at this electrode.

[Claim 2]A not less than 900 ** inside metal layer is formed in the surface of spherical substrate particulates which consist of plastic material for a melting point, A manufacturing method of an electrode connection structure object in which a melting point is characterized by allocating in the outside of the inside metal layer between electrodes which counter a conductive particle to which it comes to form an outside metal layer 350 ** or less, and heating in beyond a melting point of an outside metal layer, and temperature of [below 900 **].

[Detailed Description of the Invention]

[0001]

[Industrial Application]This invention relates to an electrode connection structure object to which a pair of electrodes were connected conductively, and a manufacturing method for the same by the conductive particle used for the detailed inter-electrode conductive connection in the electronics mounting field, for example.

[0002]

[Description of the Prior Art]What formed the metal plating layer in the surface of the plastic particulates which consist of polystyrene, a polyphenylene sulfide, phenol resin, etc. as this kind of a conductive particle is proposed (for example, JP,S62-185749,A, JP,H1-225776,A).

[0003]However, in inserting such a conductive particle between the electrode surfaces which counter and producing an electrode connection structure object, since the contact area of an electrode surface and a conductive particle is small, there is a fault that electric connection is unstable.

[0004]In order to make more stable contact with the electrode surface at the time of using these conductive particles, The method of fixing particulates to an electrode is proposed by forming a low melting point metal metal skin in the surface of plastic particulates, and carrying out melting of this metal skin (for example, JP,S61-77279,A, JP,S63-231889,A).

[0005]However. [the method indicated to above-mentioned JP,S61-77279,A] Since contact with an electrode was secured by carrying out melting of the metal skin which exists in the surface of plastic particulates, variation was produced in the thickness of the metal skin, and there was a fault that a contact resistance value always could not be kept low. Although providing the thickness of the metal skin beforehand more than predetermined is also considered, only the position which a metal skin spreads too much at the time of melting in such a case, and is considered as a request cannot be connected conductively.

[0006]Also in the method indicated to above-mentioned JP,S63-231889,A, since electric contact to a substrate was secured by carrying out melting of the 1st and 2nd metal layers formed in the outside of particulates, respectively, it had the same fault as the above.

[0007]

[Problem to be solved by the invention][the place which this invention solves the above-mentioned conventional problem, and is made into the purpose] By increasing a contact area with an electrode substrate, a contact resistance value can be lowered, a contact resistance value low moreover always can be maintained, and it is in providing the electrode connection structure object whose connection reliability with an electrode improved, and its manufacturing method.

[0008]

[Means for solving problem]A not less than 900 ** inside metal layer is formed in the surface of spherical substrate particulates on which the electrode connection structure object of this invention consists of plastic material for a melting point, a melting point is allocated by the outside of the inside metal layer between the electrodes in which the conductive particle in which it comes to form an outside metal layer 350 ** or less counters, and melting adherence of the outside metal layer of this conductive particle is carried out at this electrode -- the feature **** -- it is characterized by things and the above-mentioned purpose is attained by that.

[0009]** and the above-mentioned conductive particle are allocated between the electrodes which counter, it is characterized by carrying out melting adherence of the outside metal layer of this conductive particle at the electrode, and, as for the manufacturing method of the electrode connection structure object of this invention, the above-mentioned purpose is attained by that.

[0010][the manufacturing method of the electrode connection structure object of this invention] A not less than 900 ** inside metal layer is formed in the surface of the spherical substrate particulates which consist of plastic material for a melting point, A melting point allocates the conductive particle which comes to form an outside metal layer 350 ** or less in the outside of the inside metal layer between the electrodes which counter, it is characterized by heating in beyond the melting point of an outside metal layer, and temperature of [below 900 **], and the above-mentioned purpose is attained by that.

[0011]As a material which forms the spherical substrate particulates (it is only hereafter called "substrate particulates" for short) which consist of plastic material used for this invention, the following are raised, for example. Polyethylene, polypropylene, polymethylpentene, polyvinyl chloride, Polytetrafluoroethylene, polystyrene, polymethylmethacrylate, Polyethylene terephthalate, polybutylene terephthalate, polyamide, A line or crosslinked polymers, such as polyimide, polysulfone, polyphenylene oxide, and polyacetal; An epoxy resin, Phenol resin, melamine resin, unsaturated polyester resin, a divinylbenzene polymer, Resin which has

network structure, such as a divinylbenzene styrene copolymer, a divinylbenzene acrylic ester copolymer, a diallyl phthalate polymer, a triallyl isocyanurate polymer, and a benzoguanamine polymer.

[0012]Among these resin, especially a desirable thing is resin which has network structure, such as a divinylbenzene polymer, a divinylbenzene styrene copolymer, a divinylbenzene acrylic ester copolymer, and a diallyl phthalate polymer.

[0013]As substrate particulates, the thing of the shape of a real ball and the shape of an ellipse ball is mentioned, for example. In the case of-like [real ball], the diameter in which the range of a diameter of 0.1-100 micrometers is at best especially preferred is 0.5-50 micrometers, and a still more desirable diameter is 1-20 micrometers. In the case of-like [ellipse ball], the range of a minor axis of 0.1-1000 micrometers is good, and the desirable range is 1-100 micrometers. Ranges that it is good that it is the range of 1-10 as for the ratio of a major-axis minor axis and desirable are 1-5. Especially the spherical thing of substrate particulates is preferred, and that [their] as which the rate of recovery after the K-value by the compression test mentioned later and compression modification was specified is preferred.

[0014][as a material which the inside metal layer used for this invention has conductivity, and a melting point is a not less than 900 ** thing, and forms this inside metal layer] For example, gold (melting point: 1064 **), silver (melting point: 962 **), copper (melting point: 1085 **), Platinum (melting point: 1772 **), palladium (melting point: 1554 **), cobalt (melting point: 1494 **), nickel (melting point: 1455 **), iron (melting point: 1535 **), or the alloy that makes these the main ingredients is raised.

[0015]Methods of forming an inside metal layer in the surface of the above-mentioned substrate particulates include physical deposition methods, such as a method by electroless deposition, vacuum evaporation, ion plating, and ion sputtering, etc.

[0016]This method will be divided into the following etching processes, AKUCHIBESHON processes, chemicals nickel plate processes, and golden substitution plating processes, if the case of golden substitution plating is mentioned as an example and the formation method of the metal layer by an electroless deposition method is explained.

[0017]An etching process is a process for giving the adhesion of a metal skin by making unevenness form in the surface of substrate particulates, and caustic soda solution, concentrated hydrochloric acid, concentrated sulfuric acid, or a chromic anhydride is used as an etching solution, for example.

[0018]An AKUCHIBESHON process makes a catalyst bed form in the surface of the etched substrate particulates, and it is a process for activating this catalyst bed. A deposit of metallic nickel in the below-mentioned chemicals nickel plate process is promoted by activation of a catalyst bed. Concentrated sulfuric acid or concentrated hydrochloric acid is made to act on the catalyst bed which consists of surface Pd^{2+} and Sn^{2+} of substrate particulates, dissolution removal only of Sn^{2+} is carried out, and Pd^{2+} is metalized. Palladium activity agents, such as caustic soda thick solution, are activated, and sensitization of the metalized palladium is carried out.

[0019]A chemicals nickel process is a process which makes a metallic nickel layer form in the surface of substrate particulates in which the catalyst bed was formed further, for example, returns nickel chloride with sodium hypophosphite, and deposits nickel on the surface of substrate particulates.

[0020]Nickel is made eluted, putting the substrate particulates which are carried out in this way and by which nickel was covered with the golden substitution plating process into golden potash cyanide solution, and carrying out temperature up, and gold is deposited on the substrate particulate surface.

[0021]The thickness of the above-mentioned inside metal layer has the preferred range of 0.02-5.0 micrometers. Desired conductivity will be hard to be acquired if thickness is less than 0.02 micrometer. If thickness exceeds 5.0 micrometers, this metal skin will exfoliate easily from the difference of the coefficient of thermal expansion of substrate particulates and an inside metal layer, etc.

[0022][as a material which the outside metal layer used for this invention has conductivity, and a melting point is a thing 350 ** or less, and forms this outside metal layer] For example, the alloy etc. which make the main ingredients the alloy of indium (melting point: 157 **), tin (melting point: 232 **), lead (melting point: 328 **), and tin-lead or these are raised.

[0023]Methods of forming an outside metal layer in the outside of an inside metal layer include two, the method by an electroless deposition method which was described above, and a mechanical and physical method. That the latter is mechanical, after mixing beforehand the particulates in which the inside metal layer was made to form, and low melting point metal particulates as a physical method, The method of making an outside metal layer (low melting point metal thin film) forming by a collision or shear of particles is employable by the hybridization or a mechanofusion method.

[0024]The thickness of an outside metal layer has the preferred range of 0.02-5.0 micrometers. Desired conductivity will be hard to be acquired if thickness is less than 0.02 micrometer. Since the dissolved outside metal layer spreads too much in an electrode surface

when heating on both sides of the obtained conductive particle to inter-electrode [two], if thickness exceeds 5.0 micrometers, desirable anisotropy conductive connection will be barred. In a conductive particle with greater than 5 micrometers in thickness of an outside metal layer, the inconvenience a particulate comrade's condensation becomes easy to produce is also produced.

[0025][as an electrode used in the electrode connection structure object of this invention] There are an electrode in which the ITO thin film was formed on the glass plate, an electrode in which the aluminum thin film was formed on the glass plate, an electrode which stuck the copper sheet on the plastic film, etched this, and was created, an electrode which printed and created silver paste and carbon black on the film, etc.

[0026]Next, an example of the electrode connection structure object A of this invention is explained with reference to Drawings. As shown in drawing 1, the electrode connection structure object A allocates the above-mentioned conductive particle 9 among a pair of electrodes 4 and 5 which counter, and melting adherence of the outside metal layer 1 of the conductive particle 9 is carried out at each electrodes 4 and 5, and it is constituted. In this example, one electrode 4 is formed with an ITO thin film, and is provided on the glass plate 6. The electrode 5 of another side is formed with a copper circuit pattern, and is provided on the polyimide film 7. And it fills up with the binder 8 of electric insulation between the glass plate 6 and the polyimide film 7.

[0027]For producing this electrode connection structure object A, it can carry out as follows.

[0028]That is, only the conductive particle 9 is arranged on the electrode 4, without applying what distributed the conductive particle 9 uniformly with screen-stencil or a dispenser into the insulating binder 8, or using the binder 8 on one electrode 4. The conductive particle 9 may be sprinkled from the upper position of the electrode 4, or may carry out the electric charge of the conductive particle 9, and may be made to adhere on the electrode 4 electrostatically in the case of the latter.

[0029]Next, another electrode 5 is piled up on the above-mentioned electrode 4. The two electrodes 4 and 5 are pressurized in this state. Here, as welding pressure, a big thing is not needed in particular. The pressure which is a grade at which the contact state of the conductive particle 9 and the 4 or 5th page of an electrode is maintained may be sufficient. Next, the layered product by which the conductive particle 9 was pinched among a pair of electrodes 4 and 5 in this state is heated. Cooking temperature is higher than the melting point of the outside metal layer 1 of the conductive particle 9, and the temperature which is less than 900 ** is chosen. In particular, 160-300 ** is preferred. As a heating method, press heating is preferred. It is required to make pressurization maintain after heating until a layered product cools and the outside metal layer 1 solidifies. Thus, the electrode connection structure object A in which the outside metal layer 1 of the conductive particle 9 as shown in drawing 1 carried out melting adherence at the electrodes 4 and 5 is acquired.

[0030]Next, the above-mentioned K-value is explained.

[0031]According to 42 pages of the "theories of elasticity" (Tokyo Tosho 1972 issue) in loun DAU Lifshits ************, the contact problem of an elastic sphere that a radius is two of R and R', respectively is given by a following formula.

[0032]h=$F^{2/3}$ [D^2 (1/R+1 / R')] $^{1/3}$ -- (1) D= (3/4) [(1-$sigma^2$) /E+(1-$sigma'^2$)/E'] -- (2) Here, h expresses the difference of the distance of the center to center of R+R' and both balls, and, as for F, elastic-modulus [of two elastic balls], sigma, and sigma' expresses the POASSON ratio of an elastic ball, as for compressive force, E, and E'.

[0033]When transposing a ball to the board of a rigid body and compressing from both sides, on the other hand if R'->infinity and E>>E', a following formula will be obtained approximately.

[0034]F= ($2^{1/2}$/3) ($S^{3/2}$) (E-$R^{1/2}$) (1-$sigma^2$) -- (3) S expresses the amount of compression modification here. Modification of this formula will obtain a following formula easily.

[0035]= [K] (3/$2^{1/2}$), F, and $S^{-3/2}$ and $R^{-1/2}$ -- (4) -- = [formula:K] (3/root2), F, and $S^{-3/2}$ and $R^{-1/2}$ which therefore expresses a K-value -- (5) is obtained.

[0036]This K-value expresses spherical hardness universally and quantitatively. By using this K-value, it becomes possible to express the suitable hardness of substrate particulates quantitatively and uniquely.

[0037][and by using the substrate particulates whose range of 250 kgf/mm^2 - 700 kgf/mm^2 is / the K-value in a compressive strain / preferred and which are within the limits of this 10%] For example, when producing an electrode connection structure object, and a counter electrode side is not damaged by substrate particulates and a pressurizing press performs gap **** between two electrodes, gap control can be performed easily. The K-values in a more desirable 10% compressive strain are 350 kgf/mm^2 - 550 kgf/mm^2.

[0038]When a K-value exceeds 700 kgf/mm^2, even if it applies compressive load to inter-electrode [two] on both sides of this conductive particle, a conductive particle does not change easily, and, as a result, the contact area of a conductive particle and an electrode surface does not spread, but it becomes difficult to reduce a contact resistance value. When load is added by force in order to change a conductive particle, a tear and peeling of the conductive layer on the surface of a conductive particle (an inside metal layer and an outside metal layer) arise or an electrode connection structure object is produced, there is a possibility of attaching a crack to an electrode surface.

[0039]Since compression changing will become often excessive if compressive load is applied to inter-electrode [two] on both sides of this conductive particle when a K-value is less than 250 kgf/mm^2, It becomes impossible for the conductive layer on the surface of a conductive particle to follow this modification, and, as a result, a risk of a tear and peeling of a conductive layer occurring arises. The amount of compression modification becomes excessive, the situation [a conductive particle is flat, then] where an electrode comrade contacts directly occurs, and the problem of detailed connection becoming impossible is also produced.

[0040]By the way, the strength-of-materials character of suitable substrate particulates cannot be completely expressed only by specifying the suitable hardness of the substrate particulates used for electrode connection structure objects, such as a liquid crystal display element.

[0041]Another important character is that the rate of recovery after the compression modification which is a value which shows the elasticity of substrate particulates is in a prescribed range. It becomes possible by specifying the rate of recovery after compression modification to express the elasticity thru/or elasto-plasticity of substrate particulates quantitatively and uniquely. In the substrate particulates used for this invention, the rate of recovery after compression modification of substrate particulates has 30% - 80% of preferred range in 20 **. If especially the rate of recovery after desirable compression modification carries out pressurization adhesion inter-electrode [two] on both sides of the adhesives which distributed this conductive particle, and it is decompressed after adhesives' hardening when the rate of recovery which is 40% - 70% of range exceeds 80%, Since it is easy to carry out elastic recovery of the conductive particle which carried out compression modification, there is a possibility that the situation where an adhesives layer lengthens and is removed from an electrode surface may occur.

[0042]Although an adhesives layer repeats contraction and expansion under the environment of a cold energy repetition, [the electrode connection structure object produced by the method of carrying out pressurization adhesion inter-electrode / two / on both sides of the adhesives which distributed this conductive particle, and decompressing after adhesives' hardening when a rate of recovery is less than 30%] Since a conductive particle is in the state by which compression modification is carried out, a gap is

produced very much between the surfaces at the time of expansion of an adhesives layer, and there is a possibility of causing loose connection.

[0043]In this invention, the spherical substrate particulates which consist of plastic material in that come out and it can perform easily adjusting the above-mentioned K-value and a rate of recovery in a mentioned range are used.

[0044]Therefore, substrate particulates are = [K] (3 / root2), F, and $S^{-3/2}$ and $R^{-1/2}$. [A load value [in / here / in F and respectively S / 10% compression modification of substrate particulates] (kgf), The value of K defined by that it is compression displacement (mm) and R is a radius (mm) of substrate particulates] is the range of 250 kgf/mm^2 - 700 kgf/mm^2 in a 10% compressive strain, And that whose rate of recovery after compression modification is 30% - 80% of range in 20 ** is used suitably.

[0045]Next, the measuring method of the rate of recovery after a K-value and compression modification is explained.

[0046](A) The measuring method and condition (i) of a K-value In measuring method room temperature, substrate particulates are sprinkled on the steel plate which has the smooth surface, and one substrate particulate is chosen from the inside. Next, substrate particulates are compressed in the smooth end face of a pillar with a diameter [made from a diamond] of 50 micrometers using a minute compression tester (made by PCT-200 type Shimadzu). Under the present circumstances, compressive load is electrically detected as electromagnetic force, and compression displacement is electrically detected as displacement by an operation transformer.

[0047]And the relation of compression displacement-load as shown in drawing 3 is called for. From drawing 3, the load value in 10% compression modification of substrate particulates and compression displacement are called for, respectively, and the relation of a K-value and a compressive strain as shown in drawing 4 from these value and (5) types is called for.

[0048]However, a compressive strain expresses with % the value which broke compression displacement by the particle diameter of substrate particulates.

[0049](ii) Compression velocity constant load speed compression technology performed. Load increased at a rate of a 0.27-g pile per second (grf).

[0050](iii) test load -- it was referred to as a maximum of 10 grf.

[0051](B) The measuring method and condition (i) of the rate of recovery after compression modification In measuring method room temperature, substrate particulates are sprinkled on the steel plate which has the smooth surface, and one substrate particulate is chosen from the inside. Next, substrate particulates are compressed in the smooth end face of a pillar with a diameter [made from a diamond] of 50 micrometers using a minute compression tester (made by PCT-200 type Shimadzu). Under the present circumstances, compressive load is electrically detected as electromagnetic force, and compression displacement is electrically detected as displacement by an operation transformer.

[0052]And after compressing substrate particulates to a reversal load value to be shown in drawing 5 (a curve (a) shows among drawing 5), load is reduced conversely (a curve (b) shows among drawing 5). Under the present circumstances, the relation between load and compression displacement is measured. However, let the terminal point in an unloading pile be a starting point load value more than 0.1 g instead of load value zero. The value which expressed with % the ratio (L_2/L_1) of displacement L_1 to the point of reversal to displacement difference L_2 to the point of taking a starting point load value from a point of reversal defines a rate of recovery.

[0053](ii) Compression velocity 0.029 grf/sec measurement room temperature in measurement condition reversal load value 1grf starting point load value 0.1 grf load and ****** The substrate particulates used for 20 ** this invention may be colored. The example of the colored substrate particulates is indicated by JP,57-189117,A, JP,S63-89890,A, JP,H1-144021,A, JP,H1-144429,A, etc., and the coloring substrate particulates indicated by these may be used for it, for example.

[0054]

[Function]If the conductive particle 9 is allocated between the electrodes 4 and 5 which counter and beyond the melting point of the outside metal layer 1 heats at the temperature below 900 **, as shown in drawing 2 from drawing 1, melting of the outside metal layer 1 will be carried out, and it will come to fill the gap of the contacting parts of the inside metal layer 2 and the electrodes 4 and 5. On the other hand, since the melting point of the inside metal layer 2 is high, at the time of heating, melting of it is not carried out to not less than 900 **, and even after the outside metal layer 1 carries out melting, the conductive layer of predetermined thickness exists in the substrate particulate 3 surface.

[0055]Therefore, the fusion zone 1a of the outside metal layer 1 contributes to electric conduction of the contact portion of the conductive particle 9, and the electrode 4 and the 5 surface, The high-melting inside metal layer 2 will contribute to the conduction of the conductive particle 9, and the two electrodes 4 and 5 will be connected conductively via the fusion zones 1a and 1a of the outside metal layer 1, and the inside metal layer 2.

[0056]In the electrode connection structure object of such composition, since the contact area of the conductive particle 9 and the electrodes 4 and 5 has spread, a contact resistance value is reduced sharply. Since the fusion zone 1a of the outside metal layer 1 filled the gap of the conductive particle 9 and the electrodes 4 and 5 and has stuck it to the electrode surface, the electrodes 4 and 5 of two upper and lower sides are connected firmly. Therefore, when doing the heat cycle test of an electrode connection structure object, the electrode 4 often seen conventionally and inconvenience which the conductive particle 9 separates from the 5 surface are not seen at all.

[0057]

[Working example]This invention is explained in detail based on a work example below.

[0058]After carrying out suspension polymerization of the work-example 1 tetramethylolmethane triacrylate, the mean particle diameter of 7.05 micrometers and the resin particulate of 0.25 micrometer of standard deviation were obtained by classification. The K-value in 10% of the compressive strain of this resin particulate was 475kgf/mm^2, and the rate of recovery after compression modification was 55%.

[0059]After performing electroless nickel plating to this resin particulate, unelectrolyzed yne JUUMU plating was further carried out to that outer circumference.

[0060]Thus, as a result of analyzing an obtained conductive particle, yne JUUMU was plated for nickel 11.2weight % 20.3weight %.

[0061]Next, the conductive particle 1.0g and 0.5 g of glass fibers (5.5 micrometers in diameter and average length of 27.5 micrometers) were mixed with 75g of epoxy resin (product SEmade from Yoshikawa-ized **-4500), and its curing agent 25g, and a

paste was created. Next, after applying the above-mentioned paste by fixed thickness on a glass electrode in which an ITO film which has 30-ohm surface resistance was formed in the whole surface, a FPC electrode (that by which a copper electrode electrode width of 100 micrometers, and [inter-electrode / 100 micrometers] in width was formed on 30 polyimide films) was piled up. Next, this layered product was inserted into a pressing machine, and heat crimping was carried out for 20 minutes at pressure of 0.2 kg/cm^2, and temperature of 180 **. Then, a press was cooled and yne JUUMU in which a conductive particle carried out melting was solidified.

[0062]Thus, the high temperature side set a produced electrode connection structure object to a cold energy shock test machine (Tabai Espec Corp. make TSV-40 type) with which the low temperature side operates in -40 ** and 1 hour, and examined it up to 240 cycle for 90 ** and 1 hour.

[0063]The resistance between the contiguity copper electrodes in the copper electrode end in this electrode connection structure object was measured.

[0064]When the resistance in the above-mentioned reliability test order was measured, the result shown in Table 1 was obtained. It turned out that the connection reliability of a conductive particle and an electrode is extremely superior to this result.

[0065]After performing electroless nickel plating to the same resin particulate as what was used in work-example 2 work example 1, unelectrolyzed tinning was further carried out to the outer circumference. Thus, MEMMI [nickel nickel / 22.4weight % / tin] 10.3weight % as a result of analyzing the obtained conductive particle.

[0066]Next, pasting as well as the work example 1 was carried out using this conductive particle, using this paste, for 250 ** and 5 minutes, the electrode connection structure object was produced like the work example 1, and the reliability test was carried out except having bonded by thermo-compression by 0.2 kg/cm^2.

[0067]As a result, as shown in Table 1, it turned out that the connection reliability of a conductive particle and an electrode is extremely excellent.

[0068]Electroless nickel plating was performed to the same resin particulate as what was used in work-example 3 work example 1,

and nickel coat particulates were created. Next, what mixed 3g of pewter particulates whose mean particle diameter is 0.3 micrometer was applied to the hybridizer O type machine (made in Nara Machinery Factory) to this nickel coat particulate 10g, and coating treatment was performed. As a result, the coat of the pewter was uniformly carried out to the surroundings of nickel coat particulates. As a result of analyzing the obtained conductive particle, nickel content was 18.0 weight % and pewter content was 13.8 weight %.

[0069]Pasting of this conductive particle as well as the work example 1 was carried out, and the electrode connection structure object was produced like the work example 1 for 200 ** and 10 minutes using this paste except having bonded by thermo-compression by 0.2 kg/cm^2. The reliability test was carried out about this.

[0070]As a result, as shown in Table 1, it turned out that the connection reliability of a conductive particle and an electrode is extremely excellent.

[0071]Except not performing comparative example 1 radio solution yne JUUMU plating, the electrode connection structure object was produced like the work example 1, and the reliability test was carried out about this.

[0072]As a result, as shown in Table 1, it turned out that the connection reliability of a conductive particle and an electrode is extremely inferior.

[0073]

[Table 1]

[0074]

[Effect of the Invention]According to this invention, it has the following advantages.

[0075](1) Since the fusion zone of an outside metal layer adheres to the contacting parts of a conductive particle and an electrode and a conductive particle pastes an electrode firmly, the connection reliability of a conductive particle and an electrode improves.

[0076](2) Since the fusion zone of an outside metal layer exists in the contacting parts of a conductive particle and an electrode and the inside metal layer of predetermined thickness exists on the surface of a conductive particle, the contact resistance value of a conductive particle and an electrode is reduced.

[0077](3) Since pressure excessive at the time of thermocompression bonding when producing an electrode connection structure object is not needed, don't damage an electrode surface.

[Brief Description of the Drawings]

[Drawing 1]It is an important section sectional view of one work example of the electrode connection structure object of this invention.

[Drawing 2]It is an enlarged drawing of the important section of the electrode connection structure object of drawing 1.

[Drawing 3]It is a graph in which the relation between load and compression displacement of a spacer is shown.

[Drawing 4]It is a graph in which the relation between a K-value and the compressive strain of a spacer is shown.

[Drawing 5]It is a figure explaining the measuring method of the rate of recovery after compression modification of a spacer.

[Explanations of letters or numerals]1 Outside metal layer 1a [Copper electrode 6 glass substrate 7 / Polyimide film 8 / Binder 9 / Conductive particle] Fusion zone 2 of outside metal layer Inside metal layer 3 Substrate particulate 4 ITO electrode 5

[Translation done.]